



Call for quotation FPBO FCC pilot production test

for a co-processing study on fast-pyrolysis bio-oil

Background

The European Commission, especially the JRC, see the need for a verifiable option for allocating bio-based content. Meaning a viable alternative to Carbon14 testing is required and become part of the REDII implementation processes. Based on first investigations it can be concluded that the analytical method based on radiocarbon analysis is not a suitable method for refinery co-processing of fast pyrolysis bio-oil (FPBO), because it is not sensitive enough to reliably determine the biogenic carbon content at the concentrations resulting from a co-processing that apply in the near future.

Therefore this *project* aims to deliver a mass- or energy-allocation method to attribute the bio-carbon to the different streams coming out of a refinery. Developing such a standard method has the support FPBO producers and requires the support from the refiners.

Objectives

The *project* develops and assesses a methodology that would guarantee the amount of co-processed bio-oil in an industrial (refinery) process producing fuels (liquid or gaseous). This will be based on a mass balance standard applicable to co-refining of FPBO. So a realistic refinery co-process – ideally an fluid catalytic cracking (FCC) type as it is considered the optimal future process for FPBO - shall be performed in a pilot setting. These shall be with different FPBO shares. All input, output as well as process parameters shall be measured over each process. In addition, the biological carbon content of products delivered shall be determined.

Tender basics

This tender is part of an overall *project* funded by the European Commission and executed by the European Standardization Committee, CEN. Project execution is being seconded to NEN, the Dutch Standardization Institute. NEN has appointed a *programme manager*, who acts as the contact for the test organization (*tenderer*); he/she will receive the reports and deliverables. NEN is assisted by a group of experts (*CPO group*) to advice on the effective testing and work required.

Overall, the tender consists of the following:

- I. agree on the pilot test capacity and process set-up in a session of the *CPO group*;
- II. sufficient volumes of the required FPBO as delivered by the *project manager*, shall be stored, processed and used for the execution of work;
- III. a process is to be executed where a separate stream of 0%, 5% and 10% of FPBO is injected into the riser to the FCC unit and a distillation is performed on the FCC output;
- IV. a set of input, output and process parameters as indicated in Annex A is collected and reported;
- V. take samples for the biological content determination from process outputs on the 5% and 10% FPBO process inputs, and determine the biological content in line with EN 16640;
- VI. report on the findings to the *project manager* and at a *CPO group* meeting.



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Tasks to be performed

The main tasks of the tenderer during the contracting period are:

- 1) Discussion of the test programme, the vacuum gas oil (VGO) quality foreseen and the data collection instructions with the *programme manager* and the *CPO group*;
- 2) Reception of the necessary sufficient volumes of the required FPBO, store them to prevent degradation and contamination for the time of the contracting period until they will be used. Remaining bio-oils shall be returned to the *project manager* or be discarded on request;
- 3) Procure the necessary volumes of (VGO) of 100% fossil source, providing the product certificate (composition) to the *project manager* before procurement;
- 4) Execute a stable FCC and a distillation process (process 0) resulting in an agreed upon hourly and overall production (see 'Execution of work') and collect the data required as in Annex A.
- 5) Execute a stable FCC and distillation process with 90%mass of VGO input compared to process 0 and where 10%mass of FPBO is injected into the unit via a separate injection nozzle, resulting in a similar cap-to-oil and hourly overall production as in process 0 and collect the data required as in Annex A;
- 6) Execute a stable FCC and distillation process with 95%mass of VGO input compared to process 0 and where 5%mass of FPBO is injected in the unit via a separate injection nozzle, resulting in a similar cap-to-oil and hourly overall production as in process 0 and collect the data required as in Annex A;
- 7) In addition, to determine the yield of coke production, the following shall be determined and reported as part of steps 4, 5 and 6:
 - a. air flow, temperature and pressure, catalyst circulation and M/U rate (in kg/hr)
 - b. composition in vol% (as determined by GC-type of measurement) and lower heating value of the flue gas
 - c. oxygen enrichment of the combustion air
- 8) Check on the basis of a mass balance whether the total mass input in the FCC overlaps that of the total output (before initiating the distillation step in case that is executed as a separate process). Overlapping can be regarded as $\pm 2\%$ of imbalance, where imbalance is defined as $(\text{Output}-\text{Input})/\text{Input} \times 100$.
- 9) Take samples from the process under step 6) and 7) for the biological content determination from the different distillation products (LPG, gasoline, LCO + HCO and slurry oil), the dry gas produced in the distillation and the tapped coke;
- 10) Execute biological content determination according to EN 16640 on all samples from step 8)
- 11) Store the distillation products until two months after the end of the project and have them transported or destroyed on indication of the *project manager*;
- 12) Advise *project manager* regarding the interpretation of the results collected;
- 13) Report to the *programme manager* in writing on the exercise and conclusions, including all data as determined above as well as the methods (standards and systems) used.

Execution of the work

The overall project is scheduled to end in September 2022, and the last data of the tenderer thus to be reported by 1 July 2022, preferably earlier.

Pilot processes shall be executed using the FPBO as delivered by the *programme manager*. The amount supplied and the manner of shipment depend on the agreed upon pilot process capacity which in turn depends on the unit size that the *tenderer* offers for the work. A production capacity of 1 kg per hour for the co-processing and an overall production of 5 litres minimum and 100 litres maximum are suggested, but tenderers may offer different capacity for discussion with the *CPO group*.

Because FCC is the most likely co-process available in a modern refinery set-up, this is the largely preferred option. Tenderers may however propose an alternative



pilot process explaining how that would also support the objective of the *project* and doesn't negatively impact the *project* duration.

The conversion (FCC) process shall be executed at a constant reactor temperature of ± 525 °C (± 980 F) with a riser residence time of the FPBO of approximately 2 seconds. In order to link the process to a real-world situation, the feed hydrocarbon partial pressure shall be around 12 to 15 psia (83 to 103 kPa), the catalyst inlet temperature aimed at 675 °C (1250 F) and an isothermal riser should be used. The process shall be executed under stable conditions, meaning catalyst/oil ratio shall be between 7 to 8 and conversion will drift whilst the reactor temperature is kept stable.

Property determination tests as indicated in Annex A shall be executed on representative samples from the products produced in a stable set-up. The standard test methods indicated in the Annex is the recommended ones. Alternatives can be agreed upon with the *project manager*.

The biological determination shall be executed following EN 16640 or ASTM D 6866. The lab executing the effective LSC or ASC detection should be subcontracted by the *tenderer*. The name and location of the sub-contracted lab shall be indicated in the *tender proposal* or reported to the *project manager* before the pilot process starts so that the experience with C14 determination can be checked. The *tenderer* shall consult the sub-contracted lab on the correct sampling.

A representative from the tenderer shall take part in *CPO group* meetings (foreseen at the start of contracting period and after the data reporting) in order to exchange information and cooperate in the advice to the EC and CEN.

The *tenderer* shall report to the *programme manager* about the progress and results providing a monthly progress report. The *programme manager* may visit the tenderer organization facilities to check progress and discuss the testing. The *tenderer* shall present a detailed report on the pilot process set-up, execution, registered process data, bio-content test results and related advices regarding the draft standard. The results and reports shall become property of the contractor.

The *tenderer* shall at the end of the project and on request of the programme manager destroy the remaining products and FPBO in his possession.

General confidentiality around the products involved, results, etc. shall apply and the *tenderer* shall not distribute any results other than to those involved in the tender.

The *tenderer* will present an overall planning with the tender proposal. This planning shall be confirmed at the first exchange with the *CPO group* after the contract signature.

Award criteria for the tendering process

Offers for provision of the testing and reporting are treated individually although consortium offers will also be considered. Offers can also be from a single person, who should have a VAT number and a company registration.

Selection of subcontractors will be based on the following criteria:

1) **Documented experience** (maximum 40 points):

- number of years working in relevant field
- demonstration of experience in leading and / or managing of similar projects
- demonstration of experience in pilot process testing with different (biological) feedstocks, preferably with pyrolysis oils
- demonstration of experience with (sampling for) the indicated test methods as described in Annex A, if not all being sub-contracted to a third party
- technical experience and consulting activities in relevant fields



- experience in running international research programs

2) **Organization of the work** - demonstration of ability and understanding of the project (maximum 40 points):

- infrastructure (equipment) and ideas regarding co-processing of bio-oils in a refinery set-up
- possibility to adapt the pilot refinery set-up to allow 5% and 10% FPBO co-processing
- facilities used for the pilot process
- organization of the pilot process preparation, measurements, product testing and reporting
- established quality system

Possibility to complete the processing and testing before December 2021 will be considered an advantage.

Only offers that pass the selection criteria of scoring minimum 30 points under 1) and 20 points under 2) will be further evaluated. From those passing the minimum scoring a sensible pre-selection (based on the total of the short-list) will be made and the contractor(s) invited for further evaluation in a Q&A meeting session.

3) **Quotation price** (maximum 20 points). The quotation shall give insight in the costs for:

- installing the units, measurement equipment,
- running the three processes as in step 5) to 7) and collecting and reporting the data;
- execution of the biological determinations, and
- overall organization and exchanges and meetings with the *CPO group* and the *programme manager*.

NEN considers that proposals requesting a budget in the range of 80.000 € for the described activities would allow this study to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

The offer with the highest points in total will be selected.

On the effective contract the "General Terms and Conditions for the Provision of Technical Services to NEN" shall apply. A copy of those can be delivered on request. The Contractor should also agree to the fact that the obligation of NEN to pay is subject to the normal functioning of the financing mechanisms of the Commission of the European Union and of the EFTA, through the order voucher(s) relative to the tasks under the Horizon2020 call under the Secure, clean and efficient energy programme: B.2.5. "Engine tests with new types of biofuels and development of biofuel standards" and/or through the Agreements between the Commission of the European Union and CEN on Action SA/CEN/RESEARCH/EFTA/000/2014-13.

Replies to tender

Tenders can be sent (by mail or e-mail) to the programme manager Mr Ortwin Costenoble (energy@nen.nl), as soon as possible, at the latest at 4 November 2021. The tender shall contain a specified breakdown of:

- tasks
- costs and expenses for work, travel, consumables and others where relevant
- first planning for the execution of the tasks, which will form the start of the discussion regarding the tender contract.

If necessary, additional information can be obtained via the programme manager, Mr O. Costenoble (T: +31 15 2690 330, e: ortwin.costenoble@nen.nl).



Annex A – Overview of data collection requirements

Stream	Unit	Inlet to FCC			Outlet from distillation unit (distillation)					Outlet from FCC				
		VGO	FPBO	Steam Injection	Dry Gas production	LPG (C3, C4)	Gasoline (C5 to 220°C)	LCO + HCO (220°C-360°C)	Decanted Slurry oil (360°C-End)	Water ²⁾	CO	CO2	Catalyst	Coke
Mass Flow rate ¹⁾	kg/hr	X	X	X	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X	X	X	X	X
Volumetric Flow rate ¹⁾	Sm ³ /hr	X	X		X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X				
Density ⁴⁾	kg/m ³	X	X				X	X	X					
Composition ⁵⁾	vol%				X	X								
Temperature	°C	X	X	X	X	X	X	X	X	X				
Pressure	kPa	X	X	X	X	X	X	X	X	X				
Lower Heating Value ⁶⁾	J/Kg	X	X		X	X	X	X	X					X
Higher Heating Value ⁶⁾	J/Kg	X	X											
Water content ⁷⁾	wt-%		X											
Ash content (for LHV)	wt-%	X	X											
Total carbon content ⁵⁾	%mass	X	X				X	X	X					
Speciation C3-C4 ⁵⁾	molar%					X								
Molar composition ⁵⁾	molar%				X									
True boiling point	°C						X	X	X					
Concentration of catalyst	wt-%								X					
Biocarbon content ⁸⁾	wt-%	X	X		X	X	X	X	X					X

1) Either of the flows is acceptable, can also be confirmed from the tank levels if present.

2) Water collected in the overhead drums.

3) In principle total mass or flow from the FCC are measured and a flow rate can then be calculated.

4) Density shall be measured by EN ISO 12185 or ASTM D4052.

5) For composition determination gas chromatography shall be used as basis. ISO 22854 is preferred for liquids, ISO 7941 for LPG and ISO 6974-series for methane.

6) Either a standardized test method shall be suggested by the tenderer or it is calculated from the CHO composition as determined by GC (see 5))

7) To be determined by a standardized ISO or ASTM Karl-Fischer titration method before the product is processed.

8) To be determined by EN 16640 (which is considered equivalent to ASTM D 4880)